

GEORGIA INSTITUTE OF TECHNOLOGY
Engineering Experiment Station

PROJECT INITIATION

Date: 8/13/71

Project Title: **Analysis of Pump Shaft**

Project No.: **A-232-575**

Project Director: **J. M. Akridge**

Sponsor: **Georgia Iron Works Company**

Effective **August 11, 1971** Estimated to run until: **September 18, 1971**

Type Agreement: . . **Purchase Order No. 0511** Amount: \$ **300.00**

Reports: As required

**Contact Person: A. F. Moody, Jr., Purchasing Agent
Georgia Iron Works Company
P. O. Box 626
Grovetown, Georgia 30813**

Assigned to **Chemical Sciences & Materials** Division

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GEORGIA INSTITUTE OF TECHNOLOGY
EXPERIMENT STATION 225 North Avenue, Northwest · Atlanta, Georgia 30332

A-232-575

18 August 1971

Mr. L. Reab Berry
Georgia Iron Works Company
P. O. Box 626
Grovetown, Georgia 30813

Subject: Design Analysis of Pump Shaft; Project #A-232-575

Dear Reab:

A load analysis of the pump shaft was first conducted to determine exactly how the various loads were distributed along the shaft. It was determined that there were only two loads of any significance. There is the torsional load which remains constant along the length of the shaft. In addition, there is a bending moment due to the weight of the impeller and the discharge pressure of the pump. This bending moment varies along the length of the pump, reaching a maximum at the bearing nearest the pump impeller. There is a thrust load along the length of the shaft, but it is insignificant compared to the other two loads and was neglected in the factor of safety calculations. All calculations were based on 7000 hp at an input speed of 345 RPM.

I talked with Pat Smith concerning the materials requirements to which the shaft was made. He said that you didn't have an analysis of this particular shaft, but a similar shaft had a minimum tensile yield of 80,000 PSI. This figure was used in the calculations.

The factor of safety was calculated at impeller shaft fillet, at the front bearing and at the thrust bearing groove using the A.S.M.E. Code for the design of transmission shafting. Loading and stress concentration constants recommended by the code were used along with the material strength and the combined torsional and bending moments to calculate the factor of safety at the three critical locations. The factors of safety were determined to be as follows:

| <u>Location</u> | <u>Factor of Safety</u> | <u>Comments</u> |
|-----------------------|-------------------------|---|
| Front Bearing | 4.65 | This location had the highest loads |
| Thrust Bearing Groove | 4.07 | Factor of Safety low due to keyway and groove |
| Impeller Shaft Fillet | 2.65 | Factor of Safety low due to small fillet |

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As a check of the A.S.M.E. Code and also as a means of indicating to you how uncertain some of these stress concentration factors can be, I checked the impeller shaft fillet section using the Westinghouse Code for the design of shafting. This calculation gave a factor of safety of 4.06. The Westinghouse Code is more elaborate and probably more accurate although it is not as conservative.

The analysis shows the shaft to still have an adequate safety margin at 7,000 hp provided additional stress concentrations are not introduced that are not apparent from the drawing and also provided the shaft is not subjected to heavy shock loads.

Several changes can be made to increase the margin of safety without major changes in the shaft. The recommended changes are listed below.

1. Increase fillet at impeller (an increase from $1/4$ R to $1/2$ R increases the factor of safety from 2.65 to 3.24).
2. Use Sled-runner keyways rather than Profile keyways.
3. Stop thrust collar keyway before reaching split ring groove.

Other changes are desirable but would require major modifications which probably aren't justified unless problems arise or you desire to increase power still further. I would certainly recommend that a materials analyses, both chemical and mechanical, be required with each shaft made from different metal heats.

If I can be of any additional help on this or other problems, please give me a call.

Yours very truly,

James M. Akridge

James M. Akridge
Senior Research Engineer

JMA:mb